Prospects of Renewable Energy in Gaza Strip

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Abstract:
The paper aims at the presentation of the prospects of renewable energy in Gaza strip with special emphasis on Biogas Energy. The paper starts with an idea about Gaza Strip conditions, climatic data and resources. Current activities and applications in the field of renewable energy are presented. The potential of utilizing available biogas energy from animal manure, municipal solid waste and wastewater in Gaza Strip is discussed.

Keywords:

Background:
The Palestinian Territories (PTs.) consist of two physically separated areas, the Gaza Strip (GS) and the West Bank including east Jerusalem, GS is a narrow strip with length of 42km and width of 6-12km. It stretches along the east-south corner of the Mediterranean Sea and bordering Egypt and Israel. It lies on longitude 43° 26’ east and latitude 31° 10’ north. The total area is 365km² with population of 1.13 million and can be divided into major cities, refugee comps and villages.

Gaza strip infrastructure is deteriorated due to the Israeli occupation. The main sector, which is completely deteriorated, is the environmental sector. The area suffers from shortage in water resources and the deficit between supply and demand of the aquifer is more than 45 MCM per year. The drinking water is contaminated with high concentration of chlorine and nitrate. Wastewater collection is limited to less than 60% of total population while treatment plants serve less than 40% of the population.

PTs are very poor country from point view of energy since there are no conventional energy resources. They are totally dependent on imported traditional energy from Israel. In spite of the lowermost income, It is noticed that the energy prices in PT’s are the highest in the area.

Palestinian Energy Authority (PEA) aims to minimize the dependence on traditional energy, which is totally imported and politically controlled. The use of renewable energy in PTs is a strategic goal for PEA in order to achieve some degree of economic independence.
2 Climatic Data

2.1 Temperature
Average temperatures in GS range from 13°C in winter to 27.6 in summer. The average daily maximum temperature range from 27.7 to 30.4°C and minimum temperature range from 24 to 11°C, in summer and winter, respectively, as shown in Fig. 1.

2.2 Relative humidity

2.3 Solar Radiation:
Solar insulation in GS is relatively high. The daily average on horizontal surface is about 222 W/m², which is varying during the day and throughout the year (5.58 kWh/m² day), with approximately 2861 mean-hours of sunshine annually. Figure 3 illustrates the variation in the daily average, in the total insulation on horizontal surface for each month.
2.4 Wind speed.
Generally, the wind speed in GS is considered very low throughout the year. Wind speed range between 7 and 9 km/h and 9-14 km/h in summer and winter time, respectively, as shown in Fig.4.

3 Solid Waste and Wastewater
3.1 Animal Waste
Farming in GS is considered urban farming because of the scarcity of farming land. Chickens are mainly produced locally in small family operated farms. There are 865 chicken farms in GS with farm average area of 300m². The total number of chicken produced annually is 16.9 million; and there are more than one million laying chicken for egg production. Chicken dung is contributing heavily to the environmental and health pollution since it has to rest for about 9 month before it can be used as fertilizer.
In addition, there are 4865 cows and 47,650 sheep distributed on 650 farms with an average area of 330m². The manure is usually sold to farms as fertilizer.

3.2 Residential Solid Waste
The quantities of waste collected in various places in GS are usually estimated based on the number of people served, the equipment in operation, loads transported to landfills, and the professional judgmental of experts. Estimates of solid wastes production per capita per day are different: - UNRWA estimates two liter of solid waste are generated per capita per day, The finding of the GTZ project advisor at the middle area is 0.7-0.8 kg/person/day. A study for PECDAR and EU found that 70% of the waste are organic kitchen waste with density that is also estimated at 250-600 kg/m³. On the other hand, organic waste portion is estimated around 50% on a study done by Gaza municipality.

The total amount of solid wastes produced in GS is more then 900 ton per day.

3.3 Wastewater
Wastewater produced is estimated at 80 liter per capita per day with COD of 1250-1400 mg/L and BOD of 650-700 mg/L. The total wastewater in GS is estimated at 95*10³ m³/day; however, collection is limited to less than 60% of total population while treatment plants serve less than 40% of the population.

4 Potential of Renewable Energy

4.1 Solar Energy :
Flat plate solar collector is widely used in GS since early seventies. More than 95% of houses use solar energy for domestic water heating according to 1996 statistics; however, the percentage has dropped due to the increasing number of apartment buildings that are not equipped with central solar water heating systems. The flat plate solar collector used is usually equipped with auxiliary 3.0 kWh electric heaters that are mainly used in wintertime.

Photovoltaic systems in GS are rarely used in very limited applications such as remote area housing and water pumping. This is due to the high cost of the system that give electricity with estimated cost of 0.4 USD/kWh compared to 0.11 USD/kWh for the electricity from the grid.

Solar energy is considered as potential resources in spite of the wide spread of usage of solar collectors. Potential applications include solar water desalination, solar pumping, solar crop drying and remote area electrification.

4.2 Wind Energy
As seen from Fig. 4., wind speed in GS is considered very low; therefore, potential wind applications are restricted partially to mechanical water pumping.

4.3 Biogas
Biogas can be produced from animal manure, sewage sludge from aerobic wastewater treatment plants and industrial and municipal wastes. Solid and semi-solid wastes such as the organic fraction of municipal solid waste currently disposed on landfills may be treated in anaerobic plants saving landfill space and converting the organic material to biogas energy and compost.

The amount of biogas potential from animal manure in GS can be calculated by considering Livestock Unit (LSU) which represents a live weight of 500 kg and equal to one cow, 8 fattening sheep or 250 laying hens. LSU of chicken, sheep and cow in GS are 33,800, 4865 and 6807, respectively. According to biogas yields, one LSU of cow, sheep and chicken produce in average 0.75, 0.6 or 1.25 m³. Hence, biogas resource from animal manure is around 50*10³ m³ daily which is equivalent to annual energy resources of 109 GWh.

Small community based biogas digesters could be introduced in farm which could supply the farm with needed energy for heating and lighting. Energy Research and Development Center (ERDC) at the Islamic University of Gaza is currently implementing a biogas demonstration project to introduce the biogas technology in GS communities. The demonstration project is funded by GEF/SGP and managed by UNDP/PAPP.

Waste to energy pilot project could be the beginning of the solution to the municipality solid waste problem in GS. The annual amount of organic waste in municipal solid waste is estimated at 214*10³ ton. Assuming that the whole amount of organic matter of municipal solid waste could be digested with an average biogas yield of 0.35m³/kg Volatile Solids, and that there is 0.08% VS in the organic wastes, a total of 40 GWh could be obtained.

COD value in GS wastewater is relatively high, therefore it is a good source for biogas production. Taking an average COD value of 1300 mg/L, 43225 m³/day biogas could be generated if the whole amount of organic matter of municipal wastewater could be digested. Hence, the equivalent energy of the annual biogas reserve in municipal wastewater is equivalent to 94.6 GWh.

The total biogas reserve in GS is equivalent to 243.6 GWh.

Three wastewater treatment plants are allocated in three different areas of the GS that use aerated lagoon system. This system is not promising in GS because of the problems of overloading and the unavailability of land required for such system. Decentralized wastewater treatment system (DEWATS) could be introduced in GS as alternative and/or subsidy to the treatment system in operation. DEWATS can be implemented in universities schools, hospitals, family operated farm and small urban and rural communities since it require low maintenance and provides treatment for wastewater flows from 1-500 m³ per day. Treated wastewater can be used for irrigation, sludge can be converted to compost in addition to the biogas energy produced.
5 Conclusion:
The data presented in this paper show that there is a good potential for solar energy applications such as solar water desalination, solar pumping, solar crop drying and remote area electrification. Solid wastes and wastewater treatment is of real importance for Gaza Strip economics and environments. DEWATS system and wastes to energy project should be implemented as pilot projects in GS to help in technology transfer, the spreading of the technology and to encourage local authorities to set rules and policies concerning the treatment of solid wastes and wastewater and the usage of renewable energy. Donor support is needed to promote the applications of renewable energy because of the financial difficulties in GS.

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